LESS NOISE... BETTER HEARING

ACOUSTI-CELOTEX

A. I. A. FILE NUMBER 39b

ACOUSTI-CELOTEX

Used in Buildings of All Types for Sound Absorption

ACOUSTI—CELOTEX

A Product of

THE CELOTEX COMPANY

645 North Michigan Avenue

Chicago

F O R E W O R D

TOO long has the subject of good acoustics been kept a mystery! Confusing technical terms have baffled people into thinking that sound control involves some complicated feat of engineering. It is the purpose of this booklet to sweep away these misconceptions — to show that there is, at least, *one* simple effective way of destroying sound annoyances. This way lies in the use of Acousti-Celotex.

There is no more mystery about Acousti-Celotex than there is about an ordinary red brick! It does its work because it is an excellent absorber of sound . . . it *swallows up* all distracting noises, clears the air of echoes and reverberations . . . allows only the true, intended sound to strike your ear.

Acousti-Celotex is a patented sound absorbing fibre tile. It is as free from perplexities as the a-b-c's. It comes from the factory a finished unit in itself. When applying Acousti-Celotex no finishing processes are necessary — processes which take its absorption qualities out of control. Its sound absorption qualities are *built-in*. It is *fool-proof*.

Now, acoustical properties of auditoriums and churches everywhere are being improved with Acousti-Celotex. New buildings are being Acousti-Celotexed — assuring them of satisfactory hearing conditions.

Besides improving audition, Acousti-Celotex is bringing relieving quiet into the nerve-worn world of commerce, industry and education. It subdues irritating noises . . . deadens the roar of traffic . . . increases working efficiency.

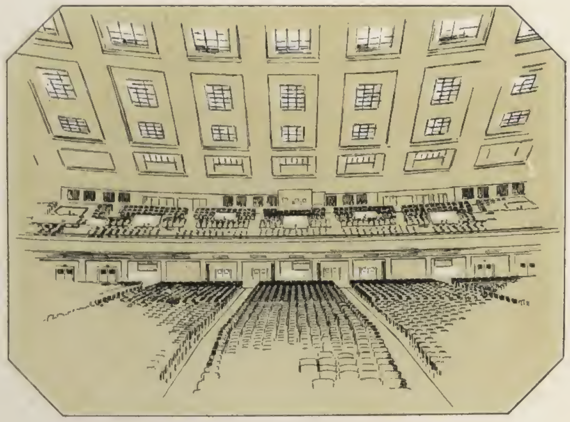
On the following pages a few pictures of installations are shown. Also, a typical acoustical problem and a typical noise quieting problem are analyzed. The concluding pages are devoted to technical information and illustrations showing the pleasing decorative possibilities of Acousti-Celotex.

Municipal Auditorium, San Antonio, Texas

Mayor John W. Tobin of San Antonio says: "We have tried out our auditorium from every angle, and I am convinced that voices from the stage can be heard clearly and distinctly in every part of the building."

Architects: Atlee B. and Robert M. Ayres, Emmett T. Jackson and George Willis.
S. W. Nichols Company, Acousti-Celotex Contractor.

MUNICIPAL AUDITORIUMS



REGARDLESS of how fine an auditorium may look, it will not draw crowds unless its acoustics are correct. People simply will not go where they cannot hear. They prefer to miss an attraction rather than have it ruined for them by echoes and extraneous noises.

Not only financial success, but very often the reputation of the town itself depends on the acoustical properties of its municipal auditorium. Delegates to conventions return home disappointed if they are not able to hear the proceedings, and are not likely to favor that city again.

Acousti-Celotex engineers are well fitted, from the standpoint of skill and experience, to handle projects of the size and importance of municipal auditoriums.

Sometimes, however, architects or building committees like to bring independent acoustical engineers into consultation. Their judgment is welcome, because their training has equipped them better to appreciate the effective manner in which Acousti-Celotex does its work.

Municipal Auditorium, Milwaukee, Wisconsin

"Our auditorium board selected Acousti-Celotex, at a cost higher than low bid, because it seemed far and away the best acoustical treatment available," says J. P. Schwada, city engineer of Milwaukee. "Our investigations showed that Acousti-Celotex was more efficient in absorbing sound at proper pitch, more durable and better architecturally."

Judell & Bogner, Architects; Wisconsin Acoustical Laboratories, Acousti-Celotex Contractor.

Municipal Auditorium, Tampa, Fla.

Frances J. Kennard & Son, Architects
Ryan Sales Company, Acousti-Celotex Contractor

BANKS AND OFFICES

THERE is a common idea that people can become accustomed to noise—that it is not harmful. Such an idea is far from the truth. Noise distracts attention . . . worries business visitors . . . uses up energy and decreases efficiency.

The constant noise in offices can be quieted with Acousti-Celotex. Office routine will show noticeable improvement. Employees will escape the late afternoon slow-down that comes from fatigued nerves.

Private offices also become restful and dignified when Acousti-Celotex is applied. Public areas, corridors and accounting divisions are quieted . . . phone conversations are easier to carry on . . . walls and ceilings absorb noises instead of emphasizing them in echoes and reverberations.

One of America's largest banks features in its advertising, "*The Courtesy of Quiet Consultation.*" In cities where office space exceeds the demand, rental agents can profit by the business man's preference for locations quieted with Acousti-Celotex.

Photograph through courtesy of Curtis Lighting, Inc.

U. S. Epperson Company, Kansas City, Missouri

This office enjoys a splendid indirect lighting system without having to sacrifice good acoustics. A painted ceiling is necessary for proper indirect light reflection, but Acousti-Celotex can be painted without harming its sound absorbing qualities.

Hoit, Price and Barnes, Architects; R. V. Aycock Co., Acousti-Celotex Contractor.

Cambridge Electric Light Company, Cambridge, Mass.

Offices of public utility companies are among those who use Acousti-Celotex to subdue the noisy confusion of the working day. Employees of the Cambridge Electric Light Company are no longer distracted by the tumult that always exists in a busy place.

F. E. Berry Jr. & Co., Inc. Acousti-Celotex Contractor.

AMERICAN CAN COMPANY, SAN FRANCISCO, CALIFORNIA

This office is connected with a machine shop. Without proper sound absorption the office workers would be continually subjected to all manner of disturbing noises. But this was safeguarded against by the application of Acousti-Celotex, which absorbs the noises and gives a pleasing decorative effect to the room.

Carl G. Preis, Architect, Western Asbestos Magnesia Company, Acousti-Celotex Contractor.

HOWARD GREY, OFFICES, CHICAGO, ILLINOIS

In small offices as well as large, Acousti-Celotex is proving popular. In the office below the tiles were laid in a basket weave pattern, showing another way in which Acousti-Celotex can be used to produce a pleasing decorative effect.

Ralph Renwick, Acousti-Celotex Contractor.

ESSEX COUNTY TRUST COMPANY, EAST ORANGE, NEW JERSEY

A beautiful ornamental ceiling, admired by all who see it, is a feature of this bank. What the people do not see, however, but never fail to notice, is the quiet that exists. Acousti-Celotex is largely responsible for the attractive ceiling, and entirely so for the quietness.

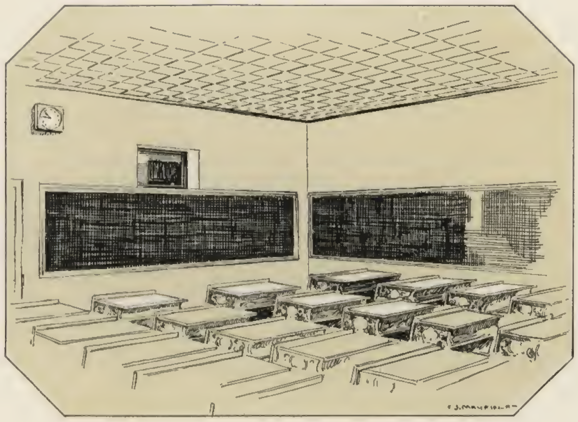
Dennison & Hirons, Architects
Rubberstone Corporation, Acousti-Celotex Contractor.

Denfield High School, Duluth, Minnesota

Here, Acousti-Celotex adds to the interest of a beautifully designed auditorium. And the school assemblies, plays and operettas are conducted without interference from disturbing echoes and reverberations, making them twice as enjoyable.

Halstad & Sullivan, Architects; Insulation Sales Company, Acousti-Celotex Contractor.

SCHOOLS AND UNIVERSITIES



MANY new activities have been added to the daily program of students since the days of the three "R's". Shop work, physical education, laboratory instruction and classes in dramatic art, music and public speaking are only a few of the later additions to school routine.

With so much going on there is bound to exist a constant din and racket. And unless these disturbing sounds are properly absorbed, they will cause nerve strain and prevent concentration.

Noise fatigue also is a menace to teachers. They work under a handicap when forced to stand the tumult echoing back from hard finished walls and ceilings.

Acousti-Celotex is finding a wide use in the correction of these harmful sound conditions. School authorities are recommending it repeatedly for class rooms, shops, corridors, gymnasiums, auditoriums, chapels, band and chorus rooms and cafeterias.

The day is approaching when Acousti-Celotex in school rooms will be considered as essential as proper illumination and ventilation.

L. C. Humes High School,
Memphis, Tennessee

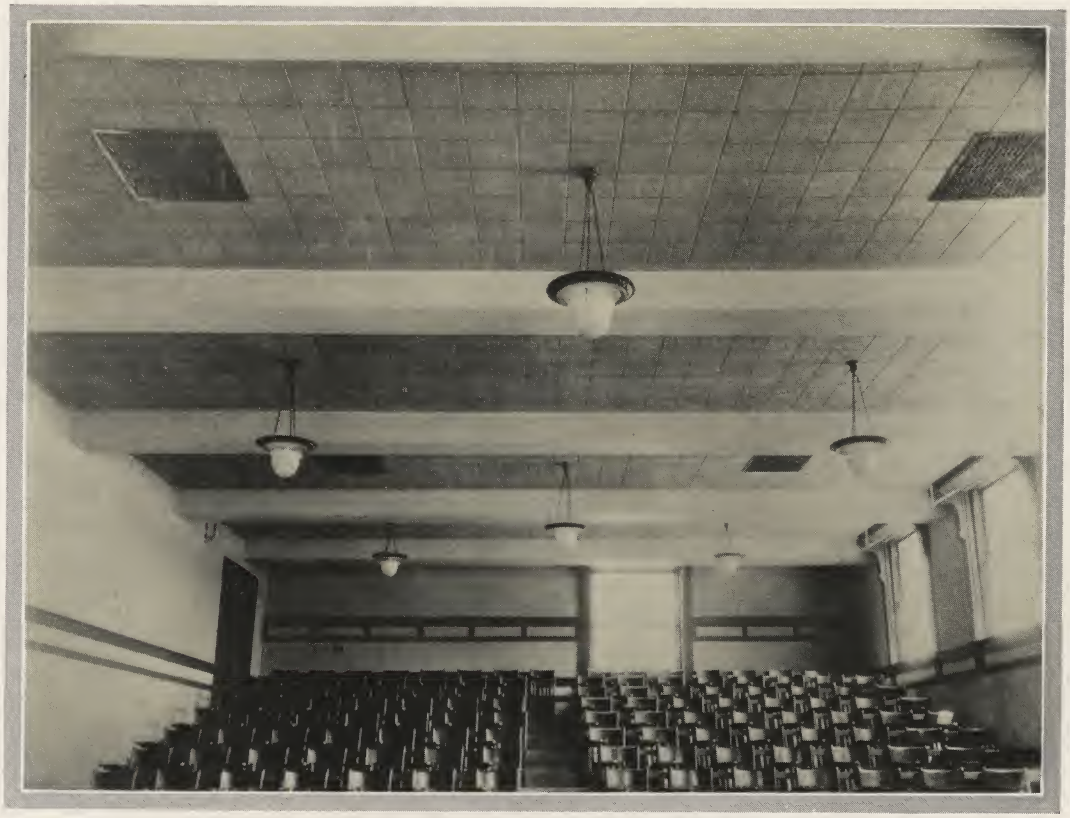
Quiet is especially essential in classrooms, where important lecture and discussion periods are held. In the classroom shown here, Acousti-Celotex protects the students from noisy surroundings, giving them a better chance to concentrate on their work.

Pfeil & Awsumb, Architects; Ryan Sales Company, Acousti-Celotex Contractor.

West High School,
Denver, Colorado

Gatherings of students in high school auditoriums usually are scenes of considerable tumult and confusion. In this school assembly room Acousti-Celotex has been applied to absorb these noises. It also adds to the decorative effect of the room.

W. Harry Edwards, Architect; Rocky Mountain Celotex Company, Acousti-Celotex Contractor.



UNIVERSITY OF TEXAS, AUSTIN, TEXAS

J. W. Calhoun, Comptroller, says, "Before this lecture room was treated with Acousti-Celotex, it was filled with echoes and reverberations of all sorts. Now the speaking conditions are perfectly satisfactory, both to the lecturer and the students."

Herbert M. Greene Company, Architect
S. W. Nichols Company,
Acousti-Celotex Contractor.

BEEHIVE SCHOOL, WARRENSVILLE, OHIO

Physical education classes and indoor games can be conducted in this gymnasium without disturbing the rest of the school with shouts and noises. These are absorbed by the Acousti -Celotex in the ceiling.

Fulton & Taylor, Architects; George P. Little Company, Acousti-Celotex Contractor.

William Jewell College, Liberty, Missouri

Chas. A. Smith, architect, who designed this Acousti-Celotex job as well as many others, says: "Acousti-Celotex has proven highly satisfactory for acoustical treatment in all auditoriums designed by us, with reference to both appearance and correction."

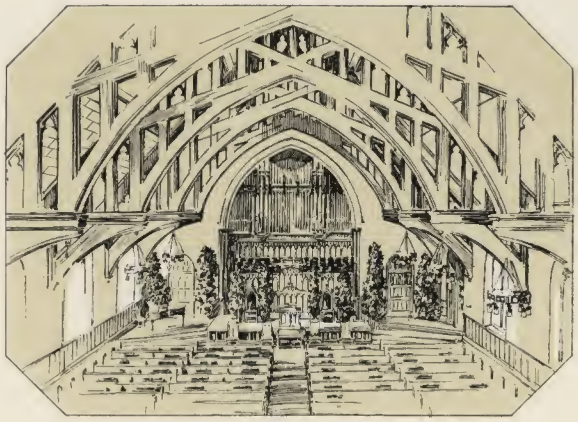
Chas. A. Smith, Architect; R. V. Aycock Company, Acousti-Celotex Contractor.

School No. 34, Indianapolis, Indiana

A pleasing appearance has been given the curved ceiling of this gymnasium-auditorium by the use of Acousti-Celotex. And there are no disquieting noises or echoes to interfere with whatever is going on.

D. A. Bohlen & Son, Architects Chas. E. Wehr, Acousti-Celotex Contractor.

C H U R C H E S



CLEAR, distinct sermons . . . inspiring anthems . . . solos everyone can hear and enjoy . . . A successful church nowadays owes much of its popularity to three things—good preaching, good music and good acoustics.

Not the least important of these is good acoustics. For no matter how delightful the choir—how inspiring the sermon—if members of the congregation must listen to rumblings and echoes they are less apt to return next Sunday.

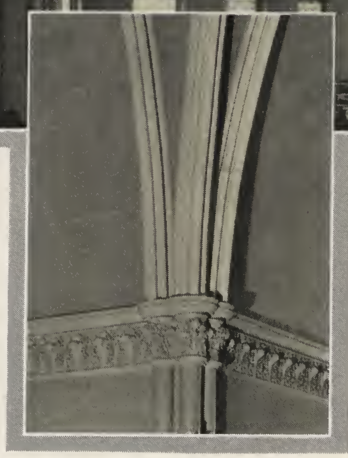
The design of a church auditorium seldom is responsible for its acoustical difficulties. Your problem can be solved by providing adequate sound absorption, so that the air will be immediately cleared of annoying reverberations.

Acousti-Celotex is permanent, for it does not crumble, rot or decay. Its natural texture is pleasing to the eye, it can be effectively decorated and it will usually fit in harmoniously with the architectural scheme.

ST. THOMAS CHURCH, DETROIT, MICHIGAN

A lofty ceiling usually introduces serious acoustical complications. This is particularly true in churches of the traditional cruciform design. In the St. Thomas church, Acousti-Celotex has kept sound conditions clear and correct. And the tiles are beautifully decorated with random staining.

Van Leyen & Schilling, Architects; George P. Little Company, Acousti-Celotex Contractor.



First Congregational Church, Clinton, Mass.

Here is another example of a high, vaulted ceiling, where Acousti-Celotex has been used to keep the correct sounds of music and speaking from being lost in a maze of echoes and reverberations.

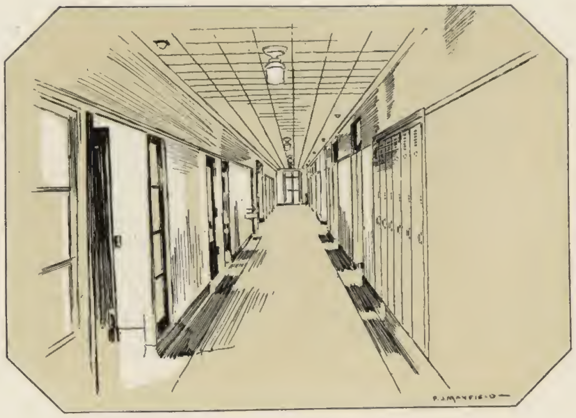
F. E. Berry Jr. & Co., Inc., Acousti-Celotex Contractor.

Bryn Mawr Community Church
Chicago, Ill.

Here, Acousti-Celotex was made to fit into panels, showing another instance of its architectural adaptability. The ceiling presents a beautiful combination of colors, as the tiles have been highly tinted and decorated.

Granger & Bollenbacher, Architects
Ralph Renwick, Acousti-Celotex Contractor.

HOSPITALS



MEDICAL authorities agree that quiet is a definite aid to speedy convalescence. It's much easier for patients to recover when their nerves are soothed with restful calm .... unbroken by noise and confusion.

Then there is the hospital staff to be considered. Their work is exacting and ofttimes very trying. If things become too noisy their nerves grow taut and serious distractions may occur.

Too many hospital corridors are like huge speaking tubes ... relaying noises from room to room. Elevator lobbies in large city hospitals, kitchens, serving and utility rooms also are sources of irritating sounds which find their way all over the building.

Acousti-Celotex quiets these disturbing noises, and enables hospital patients to enjoy continual repose. The Acousti-Celotex tiles are easy to keep clean and sanitary, even when painted or decorated.

Atchison, Topeka & Santa Fe R. R. Hospital,
Albuquerque, New Mexico

*Guy A. Carlander, Architect; Sheehan & Company,
Acousti-Celotex Contractor.*

Royal Victoria Montreal Maternity Hospital,
Montreal, Canada

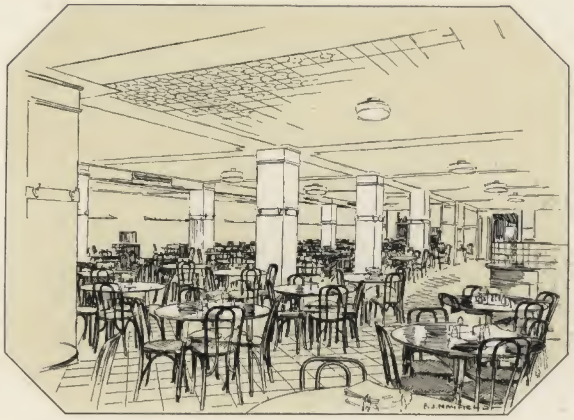
*Stevens & Lee, Architects; F. E. Berry Jr. & Co., Inc.
Acousti-Celotex Contractor.*

Michael Reese Hospital,
Chicago, Ill.

The above hospital, being thoroughly modern, has not neglected to use Acousti-Celotex for sound quieting — an excellent aid to speedy recovery.

*Schmidt, Garden & Erickson, Architects
Ralph Renwick, Acousti-Celotex Contractor.*

DINING ROOMS AND CAFETERIAS



IN busy restaurants, conversations of many people are blended into a continuous jumble of harsh, confusing noises. And in cafeterias, the crash of trays, dishes and silverware is even more irritating.

Acousti-Celotex absorbs these noises ... transforms large rooms into quiet, pleasantly restful places in which to serve food. And where there are soft strains of music from the main dining room ... how much better they sound when not mingled with noisy chatter and clattering reverberations.

Luncheon clubs, in particular, prefer to hold their meetings where quiet exists. It gives their speakers an opportunity to be heard and understood. Banquets, with musical programs and other entertainment following, are always given where guests can hear well.

People enjoy relaxing at meals ... thus quiet surroundings are almost as essential to the success of a restaurant as good food. Apply Acousti-Celotex to your kitchen and serving rooms, and your patrons will find new pleasure in coming to your establishment.

Pantlind Hotel Grill, Grand Rapids, Michigan

Fred Z. Pantlind, president of the Pantlind Hotel Co., says: "Our patrons formerly were annoyed with noise from the clatter of dishes and from talking at adjoining tables. At times, the racket seemed unbearable. Acousti-Celotex entirely eliminates these noises, besides adding to the beauty of the room."

Martin Charles Huggett, Decorator.

The Colonnade Cafeteria, Cleveland, Ohio

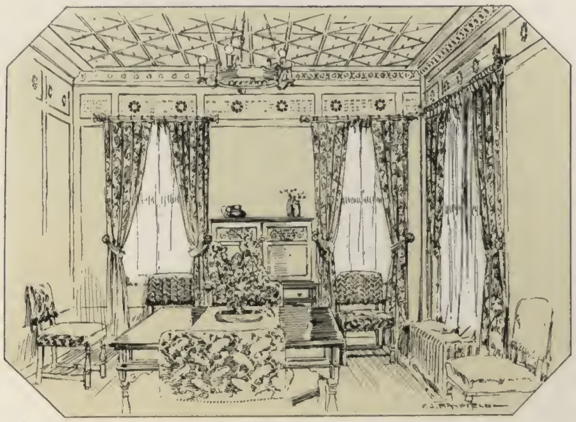
Old patrons of this establishment have made pleased comments concerning the improved sound conditions since Acousti-Celotex was installed. All noises resulting from the crashing of trays, rattle of dishes and clamor of conversation now are instantly absorbed.

George P. Little Co., Acousti-Celotex Contractor.

Judge Hebel's Court Room, Cook County Court House, Chicago, Ill.

A certain judge recently ordered a new trial in one of his cases, because the hearing conditions were so bad he feared the jury had not heard all the testimony. In Judge Hebel's court room Acousti-Celotex makes it possible for everyone to be heard clearly and correctly.

MISCELLANEOUS USES



WHEN applied in private residences, Acousti-Celotex brings new quiet to dining rooms, more peace to living rooms and additional rest to sleeping rooms. The tiles are easy to keep clean, and the decorative possibilities are unlimited.

In court rooms, each word should sound sharp and distinct, so that there will be no misunderstanding of points involved in the different cases. Acousti-Celotex makes this possible by eliminating echoes, and absorbing noises that originate in the streets.

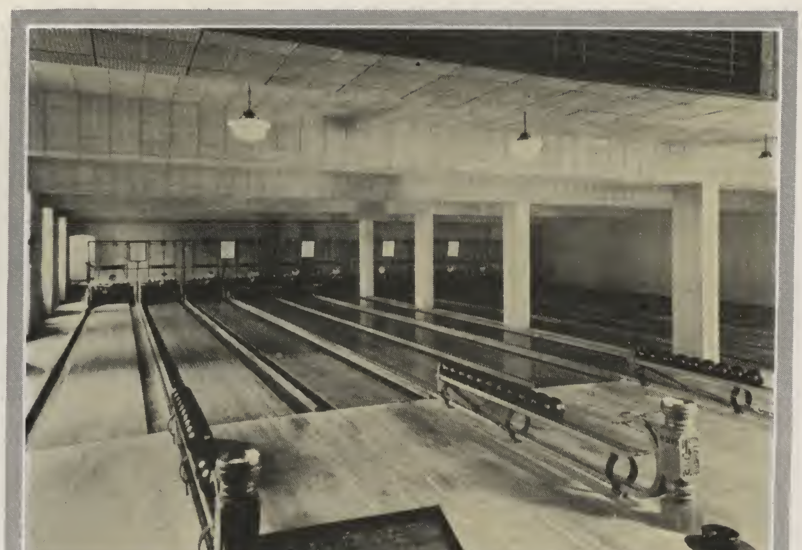
Radio stations everywhere are installing Acousti-Celotex because it reduces noise disturbance without producing disagreeably flat or dead sound conditions. It also is highly desirable in bowling alleys, as it quiets the impact and roll of the balls and the crash of the pins.

Lodge rooms, power plants, stock exchanges, newspaper editorial and press rooms, theatres, hotel banquet and ball rooms and indoor shooting ranges are just a few of the other places where Acousti-Celotex is bringing nerve-soothing quiet.

Masonic Temple, Spokane, Washington

Lodges and fraternal societies conduct services that are often religious in character. Impressive quiet, dignity of surrounding and forcefulness in ritual are made possible by the application of Acousti-Celotex. A handsome stippled, painted ceiling giving a mottled effect, was obtained in the Spokane temple.

Rigg & Vantyne, Architects; Inland Insulating Company, Acousti-Celotex Contractor.



Columbus Club Bowling Alleys, Green Bay, Wisconsin

From the thunderous impact and roll of the balls to the clatter of the falling pins, a bowling alley almost shakes with reverberations. With Acousti-Celotex applied, there is no danger of these noises becoming bothersome.

Foeller, Schoeber and Stephenson, Architects.

Radio Station KDKA Westinghouse Electric & Mfg. Co.,
East Pittsburgh, Pa.
George P. Little Company, Acousti-Celotex Contractor.

Chicago, North Shore & Milwaukee
R. R. Sub-Power Station
Winnetka, Ill.
Ralph Renwick, Acousti-Celotex Contractor.

Cotton Exchange, Dallas, Texas

The strain of activity in a cotton or stock exchange reaches feverish pressure at times. Nerves will snap unless protected against all kinds of mental irritation—principally disturbing noises. Acousti-Celotex softens these noises so that they have no ill-effects.

Lang & Witchell, Architects; S. W. Nichols Co., Acousti-Celotex Contractor.

Parke Davis & Company—Administration Building, Detroit, Michigan
Approximately 43,000 square feet of Acousti-Celotex was installed in this building to absorb bothersome noises in the different office rooms. The clanking racket of office and bookkeeping machinery thus is effectively destroyed.

Smith, Hinchman & Grylls, Architects; George P. Little Company, Acousti-Celotex Contractor.

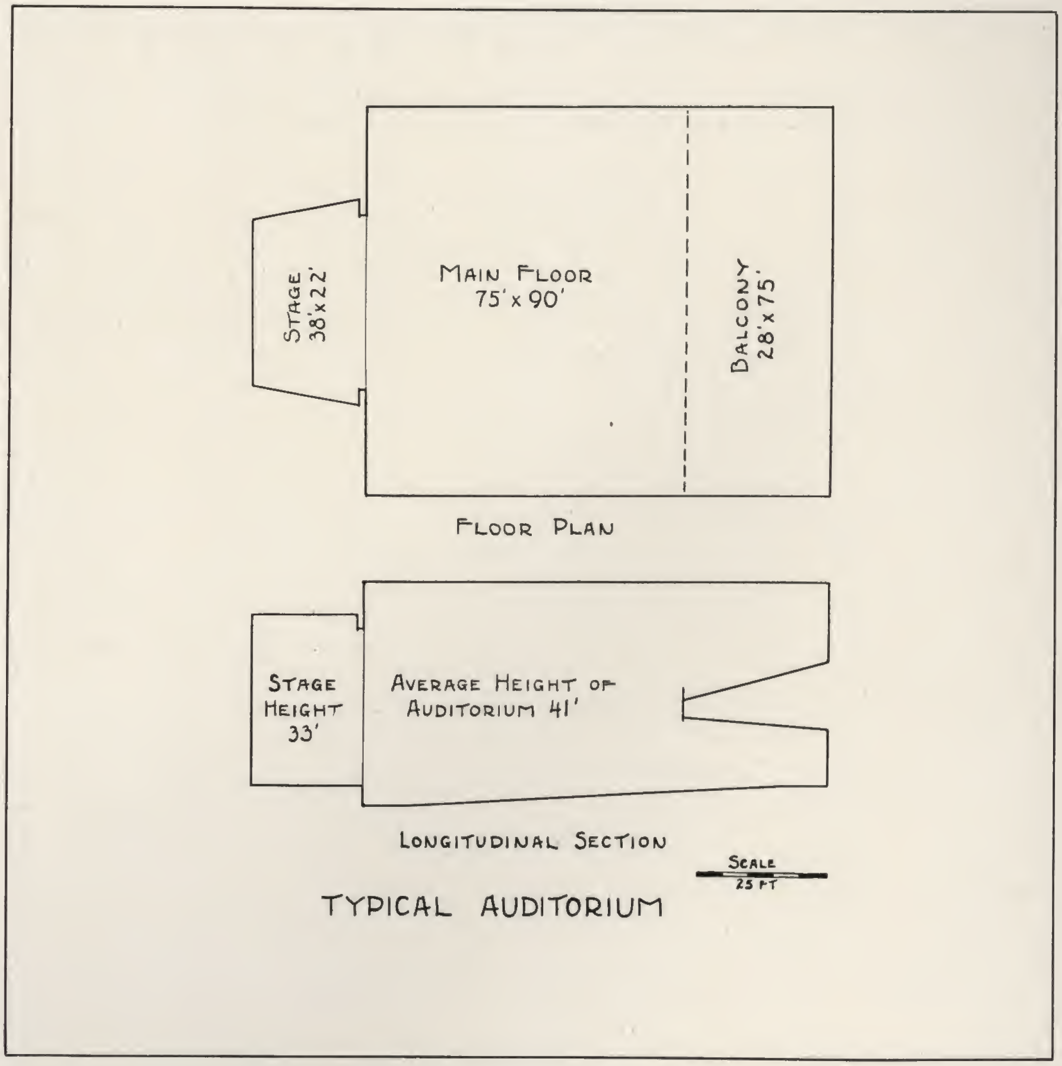
ANALYZING THE ACOUSTICS OF AUDITORIUMS

AS IT is the purpose of this booklet to throw more light on problems of Architectural Acoustics, it should contain a discussion of methods used in preparing acoustical analyses. The essential acoustical principles are easily explained. The formulae and methods used in calculating hearing conditions are so simple that anyone capable of manipulating ordinary mathematics and exercising good judgment should be able to understand and make analyses of the majority of auditoriums. Special and intricate problems exist, as in all branches of engineering science, but these need not be discussed here.

Behavior of Sound

When a sound is made in an enclosure, sound waves pass out in all directions traveling at the rate of approximately 1100 feet per second. At this speed they very quickly strike the interior surfaces of the room and are either reflected or absorbed depending on the character of the surface. Most ordinary building materials are excellent reflectors and so the waves are reflected back and forth and around the room in all directions many times until enough of the sound is absorbed so it is no longer audible. This continued reflection produces a trail of sound or a sort of ringing noise which may last several seconds after the sound is made. This continuation of the sound after it ceases at the actual source is termed reverberation.

The hearing conditions in an auditorium are dependent on two factors: the proper distribution of sound to all parts of the room, and the proper absorption of the sound after it is distributed. Proper distribution includes the even spread of sound to all parts of the room and depends largely upon the size and shape of the room and other factors which will be considered later. When the sound has reached all parts of the room it must then be absorbed to allow for the next following sound of speech or music. In a room where the reverberation following each sound continues too long, the syllables of speech or tones of music run together and are indistinct and difficult to understand. Excessive reverberation is the cause of the majority of acoustical difficulties and it is this problem that requires mathematical solution when the engineer prepares his acoustical analysis. He is given a room of definite shape and, although he can make suggestions, he is not expected to make radical alterations in the proportions. He is supposed to make that room as good as possible acoustically and he knows that, if it is of the usual shape, he can be sure of satisfactory hearing



conditions if he makes the proper adjustment of reverberation.

Method of Calculation

It is not necessary here to derive the formula used in calculating reverberation. This is generally known as the Sabine formula, taking its name from Professor Wallace C. Sabine of Harvard who developed it and did much of the pioneer work in architectural acoustics. It can be briefly stated and explained as is done with many other formulae in engineering handbooks. It is usually written:

$$t = \frac{0.05 \times \text{Volume}}{a}$$

"t" is the period of reverberation in the room in seconds length of time which a sound of standard intensity will last, as explained previously, before it becomes inaudible.

"Volume" is the entire volume of the interior in cubic feet.

"a" is the number of units of absorption present in the room. This unit is explained in the following discussion.

It has been said that when a sound wave strikes an interior surface of an ordinary room, most of it is reflected, but part of it is absorbed, the amount absorbed being dependent on the porosity and other characteristics of the surface. In order to have some basis for calculation we must have a unit of absorption; this has been chosen as one square foot of surface which absorbs all the sound that strikes it and reflects none. A surface that is totally absorbent, such as an open window, is said to have a coefficient of absorption of 1.00. No sound is reflected from such a surface. One which absorbs only one-fourth of the sound that strikes it has a coefficient of 0.25. One square foot of a surface with a coefficient of 1.0 furnishes one unit of absorption. With a surface having a coefficient of 0.25, four square feet will be required to give a unit of absorption. Thus to find the number of units of absorption present in a room, we must find the areas in square feet of each material forming part of the interior surfaces, multiply these areas by the coefficient of absorption for each particular material and add the total. Coefficients of the various materials and objects ordinarily encountered are contained in Table I on page 34.

The table lists absorption values for several individual objects, chief among which is the absorption of the audience, per person, listed at 4.7 units. This shows that the audience itself is quite a factor in determining hearing conditions. It is a common experience that an empty auditorium often sounds much different than one filled with people; the difference is caused entirely by the absorption of the audience. In the table, the seats are also given an absorption value per person. In figuring the total absorption of a room empty, the seats are included and when the absorption of the audience is added the value assigned to the seat is deducted from the absorption of the individual. For example, if the seats are taken at 0.2, when the effect of the audience is calculated, it is assumed that the absorption of the seat is removed because it is covered by the person seated and the audience is added at 4.5 units (4.7 − 0.2) each.

Thus, the formula and method used in determining the periods of reverberation is derived. The calculated periods of reverberation will be of small value, however, unless we know what periods of reverberation have been found to produce the most satisfactory hearing conditions.

Experiments and general practice have shown that the periods of reverberation which produce the best average conditions vary with the volume of the room, as shown in Table II. To correct the hearing conditions of a room of a certain volume, we try to have the period of reverberation reach the value given in the table with an average audience included. If there is not specific information to the contrary, the average audience is usually taken at about two-thirds maximum audience.

Example of Analysis

In order to make the analytical methods as clear as possible we will take an example and carry the calculations to completion in detail.

An auditorium of simple form will furnish a good illustration. Let us assume a room having a floor plan and longitudinal section as shown in outline on page 28. The main floor and balcony floor will be assumed to be concrete with carpeted aisles and the total seating capacity to be 1,200 persons. The stage floor will be varnished wood. The walls will be partly hard plaster and partly glass and all ceilings will be flat and finished in hard plaster. The dimensions of the room and its

various features can be taken from the sketches.

In a room of this shape and proportions it can be safely predicted that the distribution of sound will be adequately taken care of and we can proceed immediately with calculations of reverberation.

The volume of the room including the stage is very close to 288,000 cubic feet. To find the total number of absorbing units with the room empty, the area of each material will be multiplied by its coefficient as given in the tabulation below.

Main &				Units
Balcony Floors..	8850 sq. ft.	Concrete	@0.015,	133
Stage Floor....	840 sq. ft.	Wood	@0.03,	25
Ceilings & Walls	23200 sq. ft.	Plaster	@0.03,	696
Carpet in Aisles	1700 sq. ft.		@0.20,	340
Stage Curtain..	400 sq. ft.		@0.40,	160
Wood Seats....	1200		@0.20,	240
Total Absorption in Empty Room............				1594

We will now calculate the reverberation with the room empty, one-third full, two-thirds full, and full. One-third audience is 400 persons and the absorption of these will be taken at $4.7-0.2=4.5$ units each.

$$\text{Empty room } t=\frac{0.05\times 288{,}000}{1594}=9.0 \text{ seconds}$$

$$400 \text{ audience } t=\frac{0.05\times 288{,}000}{1594+(400\times 4.5)}=4.2 \text{ seconds}$$

$$800 \text{ audience } t=\frac{0.05\times 288{,}000}{1594+(800\times 4.5)}=2.8 \text{ seconds}$$

$$1200 \text{ audience } t=\frac{0.05\times 288{,}000}{1594+(1200\times 4.5)}=2.1 \text{ seconds}$$

Let us repeat the calculation assuming upholstered seats instead of the plain wood seats used above and see what difference it makes in the results. We will assume the seats used have an absorption value of 1.5 units each which will make the total absorption of the empty room 3154 units instead of 1594 units. The amount to be added then for each person present will be $4.7-1.5=3.2$ units. The periods of reverberation will be as follows:

$$\text{Empty room } t=\frac{0.05\times 288{,}000}{3154}=4.6 \text{ seconds}$$

$$400 \text{ audience } t=\frac{0.05\times 288{,}000}{3154+(400\times 3.2)}=3.2 \text{ seconds}$$

$$800 \text{ audience } t=\frac{0.05\times 288{,}000}{3154+(800\times 3.2)}=2.5 \text{ seconds}$$

$$1200 \text{ audience } t=\frac{0.05\times 288{,}000}{3154+(1200\times 3.2)}=2.1 \text{ seconds}$$

The results show that the period of reverberation with a maximum audience will be the same whether upholstered seats are used or not. This is to be expected from statements made previously. It also appears that with the room empty and with less than maximum audience, the upholstered seats cause less reverberation. Upholstered seats thus have a tendency to make the reverberation in the auditorium less dependent on the size of the audience.

Referring to Table II we find that the most satisfactory or optimum time of reverberation for a room of this volume is 1.6 seconds. Even with a maximum audience the time is 2.1 seconds which is too far above the optimum for best results. It can be said of this room that, although hearing conditions may be fairly satisfactory when the room is completely filled, they will not be as good as is desirable. With smaller audiences the reverberation will be excessive and the results when the room is in average use will be unsatisfactory.

Now that we have analyzed the conditions that will exist in the auditorium with the absorption furnished by regular materials used in construction and have found these conditions will be unsatisfactory, we must find how many units of absorption will have to be added to give the results we want.

The Sabine formula has been written:

$$t=\frac{0.05\times \text{Volume}}{a}$$

It can be transformed and written:

$$a=\frac{0.05\times \text{Volume}}{t}$$

And, if for "t" we substitute the time of reverberation required for best conditions which can be found in Table II,

we will find the number of units of absorption the room should have. Table II shows the optimum to be 1.6 seconds which gives

$$a=\frac{0.05\times 288{,}000}{1.6}=9000 \text{ units}$$

In this auditorium the seating capacity is not very large for the volume and, therefore, hearing conditions should be satisfactory if the reverberation reaches the optimum value with the room somewhere between two-thirds full and full, provided the reverberation does not run too high with the room empty. Without any acoustical treatment the auditorium will have 5194 units of absorption with a two-thirds audience and 6994 units with a maximum audience. Our calculation above shows that 9000 units are needed, so we should add about 3000 units of absorption in special absorbing materials and repeat the calculations of reverberation to ascertain the results.

First, let us see where we can place a special absorbing material to give the units wanted. The ceiling surface is usually a convenient one to treat, and in a room of regular shape such a placement of treatment would be considered satisfactory. The main ceiling of this room is 75′ x 90′. This gives a total of 6750 square feet, but we will assume that a plaster cornice takes part of this space and that there is a net area of just 6400 square feet available for treatment. The coefficients of absorption of the various types of Acousti-Celotex are given on Page 38. It is necessary now to pick out the type of Acousti-Celotex that can be applied on the 6400 square feet to produce approximately 3000 units. Type B has a coefficient of .47 and 6400 square feet will give 4600×.47 or 3008 units.

We can now go over the calculations again adding the 3008 units furnished. First take the case of the room with ordinary wood seats, we will have 1594+3008=4602 units with the room empty. The complete calculations are as follows:

$$\text{Empty room } t=\frac{0.05\times 288{,}000}{4602}=3.1 \text{ seconds}$$

$$\text{400 audience } t=\frac{0.05\times 288{,}000}{4602+(400\times 4.5)}=2.2 \text{ seconds}$$

$$\text{800 audience } t=\frac{0.05\times 288{,}000}{4602+(800\times 4.5)}=1.8 \text{ seconds}$$

$$\text{1200 audience } t=\frac{0.05\times 288{,}000}{4602+(1200\times 4.5)}=1.4 \text{ seconds}$$

The figures above show that the optimum of 1.6 seconds will be reached between two-thirds and maximum audience, and with anything over half audience, the reverberation will be below 2.0 seconds. Furthermore, the reverberation with the room empty is below 3.5 seconds. All of these facts and the statement that the seating capacity is somewhat small for the volume, which makes the reverberation less effected by changes in the size of the audience, make this treatment look satisfactory for general purposes.

Let us repeat the same calculations using upholstered seats, as was done with the untreated auditorium. This gives 3154+3008=6162 units for the empty auditorium.

$$\text{Empty room } t=\frac{0.05\times 288{,}000}{6162}=2.3 \text{ seconds}$$

$$\text{400 audience } t=\frac{0.05\times 288{,}000}{6162+(400\times 3.2)}=1.9 \text{ seconds}$$

$$\text{800 audience } t=\frac{0.05\times 288{,}000}{6162+(800\times 3.2)}=1.7 \text{ seconds}$$

$$\text{1200 audience } t=\frac{0.05\times 288{,}000}{6162+(1200\times 3.2)}=1.4 \text{ seconds}$$

We again have the same period of reverberation at maximum audience with, or without, the upholstered seats. The effect of the upholstered seats is to give lower reverberation with small audiences and so if a wide variation of audience is expected when the auditorium is in regular use, the upholstered seats will be helpful.

The relation between seating capacity and volume in our sample audi-

torium was taken at an average value between two extremes which themselves must often be considered. It has been seen that the absorption of the audience has a large effect on the reverberation in the room. Thus, in rooms having a large seating capacity for the volume, greater care must be used to adjust the reverberation to the optimum with an average audience; and in such cases where there may be a wide variation in the size of the audience, the optimum should be reached with two-thirds audience or sometimes even less.

Stages

In the preceding example we made no comments whatever about the stage, other than to figure in its volume as a part of the auditorium and add the absorption of its walls to the general absorption of the room. The stage opening was as large as the stage, so our procedure was safe.

If the stage house had been large with a very high ceiling and deep wings on either side, well equipped with scenes and other accessories, and the opening between the stage and auditorium had been comparatively small, then we would not have included the volume nor the absorption of the walls of the stage in our calculations. Instead we would have assumed that the stage would act as an absorber of sound from the auditorium and we would have multiplied the area of the stage opening by a coefficient of from 0.25 to 0.50, depending upon the amount of absorption in the stage house, and would have added the units of absorption obtained to the total absorption of the empty auditorium.

The acoustical treatment in our sample auditorium was all placed in the auditorium itself and none on the ceiling of the stage. Treatment of stages is sometimes desirable, but recent experiments conducted by Professor F. R. Watson, of the University of Illinois, indicate that musicians particularly enjoy reflecting surfaces about them to intensify the sound. This probably also applies to speakers as they usually dislike to stand directly in front of absorbent stage curtains. Listeners, on the other hand, seem to want to be near absorbing material. It is possible to please both performers and audience and at the same time maintain the same period of reverberation in the whole room by placing the acoustical material with the audience.

Balconies

The proper method of handling balconies in making an acoustical survey is still an open question, but a comprehensive statement of the difficulties involved will give a good idea of the procedure best adapted to each case.

Obviously, the opening between the front of the balcony and the main floor should be as wide as possible to permit sound to enter the space between. Low deep balconies should be avoided because the sound intensity is sure to be much diminished at the rear beneath them and hearing conditions will be poor. A narrow balcony opening with a high flat or domed ceiling back of it is also bad because it may form a space capable of developing a reverberant condition in itself, independent of the reverberation of the auditorium as a whole. A ceiling beneath the balcony which slopes down slightly from the front to the back is good because the conditions mentioned above are avoided and there is also a possibility of this sloping surface helping reflect sound down to the auditors in the rear seats.

The balcony may affect the calculations of reverberation in a peculiar manner in some cases. It is evident that the space beneath a balcony cannot furnish more units of absorption to the auditorium than are obtained by considering the opening totally ab-

sorbent. In other words, if we take the height of the opening from the front of the balcony to the main floor, multiply this by the width of the auditorium, and multiply this area by an absorbing coefficient of 1.00; we then have the maximum absorption which the space beneath the balcony can furnish in reducing the reverberation in the room as a whole. Calculations will show that this space need not be very deep before the absorption of the audience in it will equal the opening taken at unity, and consequently in deep spaces a large part of the audience in this space may have no effect on the reverberation in the auditorium.

The points brought out above make a change in the methods of calculation desirable with a deep space beneath the balcony. As a rule, when the depth of this space is greater than twice the height of the opening at the front, it is better practice to omit the volume below the balcony from the volume of the room and to figure the area of the opening at a coefficient of unity. The absorption of the audience in this space then should not be added at all in the calculations. A little study will show that some assumptions and approximations will be necessary in figuring the reverberation at fractional audiences, but the result in general is more accurate than would be obtained by the regular method.

Factors Influencing Distribution

Early in this discussion, it was mentioned that the phenomena which were of greatest importance in determining hearing conditions could be divided into the two classifications of distribution and absorption. The subject of distribution was temporarily waived to give an account of reverberation and its remedy, absorption, because it is usually the amount of reverberation in a room which "makes" or "breaks" it acoustically. Distribution, however, must be given attention and, although it cannot be quantitatively treated as was reverberation, the common factors which influence it should be known so that they can be used or avoided as the case may be.

Curved surfaces are usually the greatest offenders and accordingly come first. Curved surfaces have a tendency to focus sound in much the same manner that a curved reflector focuses light. Since an even distribution of sound throughout an auditorium is to be preferred, any influence which tends to focus sound at one point in an auditorium at the expense of another is objectionable. Vaulted ceilings and domes have been generally condemned but there are conditions under which they can be used with quite good results. It is a good working rule to have the radius of curvature either less than half or more than twice the ceiling height and to treat the curved surfaces with an absorbing material of fairly high efficiency. Placing an absorbing material on such a surface accomplishes two purposes. It has its regular effect in reducing reverberation and, in addition, it reduces the reflecting power of the surface and so minimizes the sound concentrations.

Curved walls, particularly curved rear walls, have been known to cause trouble, and yet they must usually present large unbroken surfaces before they are a real menace.

What are sometimes called "shadowing effects" may be caused by an insufficient amount of sound energy reaching some part of the audience because of that section being out of the direct path of the sound wave coming from the stage. To illustrate this an analogy can be drawn between hearing and vision and those features in an auditorium which produce a bad "sight line," usually cause a bad "hearing line."

In long rooms the floor should be raised toward the rear and the stage should be elevated so that each auditor will be adequately in the path of the sound wave coming directly from the stage. Reasoning along the same lines, it is to be expected that, in very wide auditoriums, the auditors at the extreme front of each side will have difficulty in hearing. At the rear, under low deep balconies, the same effect will exist.

It can be seen that, in general, sound distribution will be dependent on the design of the auditorium as laid out by the architect. There are certain designs which are known to be good for sound distribution and others which are generally considered bad. It must be remembered, however, that reverberation is a more important factor than sound distribution and the shape of an auditorium cannot in itself make the room acoustically good. On the other hand, the proper acoustical treatment of a very poorly shaped room may be so calculated and placed as to give the room fairly good hearing conditions.

Table I
Coefficients of Absorption

The following coefficients are taken from the published works and test data of Professor Wallace C. Sabine and Professor F. R. Watson. They are for the standard pitch of 512 vibrations per second.

	Units per Sq. Ft.
Open Window	1.00
Plaster	.025 to .034
Concrete	.015
Brick set in Portland Cement	.025
Marble	.01
Glass, single thickness	.027
Wood Sheathing	.061
Wood, varnished	.03
Cork tile	.03
Linoleum	.03
Carpets	.15 to .29
Cretonne Cloth	.15
Curtains in heavy folds	.50 to 1.00
Hairfelt, 1″ with painted membrane	.25 to .45
Acousti-Celotex, Type BB, painted or unpainted	.70
Acousti-Celotex, Type B, painted or unpainted	.47
Acousti-Celotex, Type C, painted or unpainted	.30
Acousti-Celotex, Type A, unpainted	.25

Individual Objects

	Units
Audience, per person	4.7
Church pews, per seat	.2
Wood seats for auditoriums, per seat	.1
Upholstered seats, per seat	1.0 to 2.5
Pew Cushion, per seat	1.45 to 2.04

Table II
Optimum Periods of Reverberation

The following table is prepared from published data compiled by Professor F. R. Watson.

	Seconds
Below 7,000 cubic feet	1.0
7,000 to 20,000	1.1
20,000 to 45,000	1.2
45,000 to 85,000	1.3
85,000 to 145,000	1.4
145,000 to 225,000	1.5
225,000 to 330,000	1.6
330,000 to 465,000	1.7
465,000 to 630,000	1.8
630,000 to 835,000	1.9
835,000 to 1,100,000	2.0

QUIETING BY ABSORBING NOISE

THE noises present in the average office come from a variety of sources. If the room is a large one in which a number of persons are working, the general "room noise" is the accumulation of sound produced by conversation, typewriters and other mechanical office equipment, bells and buzzers, the moving of chairs, the rustling of papers, the opening and shutting of desk and file cabinet drawers, and the traffic outside in the street. "Room noise" does not resemble a musical sound of any particular pitch but instead is a mixture of sounds of all pitches. It is usually not a steady noise of constant loudness but fluctuates from a moderate hum at some times to loud peaks of noise at others.

Decreasing the loudness and preventing the spread of noise are the functions of Acousti-Celotex which make it valuable as a quieting agent. It accomplishes results by absorption, as in auditoriums, but the considerations leading to its use are somewhat different.

Loudness

The loudness of sound in a room is dependent upon two factors; the quantity of sound produced, and reflection from the surfaces of the room. Noise will be made and, altho measures may be taken to prevent some of it, the increasing use of machines of all kinds in our cities, assures a steady growth in the quantity of noise produced inside of or entering into offices from the streets. The possibility of the greatest noise reduction is in absorption.

When a sound is made in a room the sound wave travels out in all directions at a speed of about 1100 feet per second. It almost immediately strikes some of the interior surfaces of the room and is reflected. Some of the sound energy may be absorbed, depending upon the character of the surface, but in the case of ordinary hard plaster about 97% is reflected. The sound is traveling so fast that, in an ordinary office, reflections may occur at the rate of 50 times per second. These reflections add to the original sound so as to build up a loudness much greater than if the source of sound were out in the open air free from the surrounding walls. In this way sounds literally are repeated time after time in such rapid succession that the ear does not distinguish between the individual echoes but senses them all collectively as a noise of disturbing loudness.

Here enters the principle of sound

absorption. Covering some of the interior surfaces of a room with Acousti-Celotex reduces the amount of sound reflected and greatly reduces the total loudness of the sound. Instead of continued repetition of a noise, after a few reflections so much of the sound energy has been absorbed that the noise is no longer audible.

In practice, it is the average loudness of sound thruout the room, produced by a certain sound source, with which we are chiefly concerned. Technically, there are various ways of expressing the amount of sound energy but it is the loudness of the noise as perceived by the ear that determines its effect in disturbing us.

The loudness of a sound in a room varies with the amount of absorption. Increasing the number of absorbing units in a room by installing a certain amount of Acousti-Celotex will produce a definite difference in the average loudness of noise. The louder the noise to begin with the greater must be the absorption added to produce a certain lower noise level. Expressed in another way, Type B Acousti-Celotex may reduce the loudness of an average noise by 50%, while Type BB may be required to reduce the loudness of a greater noise to the same extent.

Spread of Sound

In large offices, the spread of noise from one part of the room to other parts is of great importance. In a typical office room with a low ceiling, where there is very little absorption in the room, it can be shown experimentally that the loudness of noise produced by a source of sound in one corner is fairly uniform thruout the room. There will be differences in intensity caused by what is called the sound pattern but, in general, the sound will seem about as loud across the room as it does fairly close to the source. Now where the entire ceiling of the office is covered with Acousti-Celotex, the noise does not carry so well to other parts of the room distant from the source. Twenty-five feet away, the noise may only be half as loud as when five feet away.

Preventing the spread of objectionable noise is probably one of the most important results of covering the ceiling of an office with Acousti-Celotex. Conversation in one part of the room should not disturb those working in another part. An adding machine operating in one corner need not produce so much noise a few feet away as to make telephone conversation impossible. Street noises coming through the open windows can be reduced in loudness at the outside wall and prevented from disturbing everyone in the room.

Solution of Noise Problem

In the discussion of quieting noise by absorption, we have emphasized the dual accomplishment of Acousti-Celotex; the reduction of the average loudness of noise in a room, and the prevention of the spread of noise. Experience and theory show that the amount of noise if reduced and prevented from spreading is dependent on the amount of absorption added. Since there are no definite mathematical calculations to be used in determining the amount and type of Acousti-Celotex to use in quieting, additional comments will help in reaching a decision.

The average loudness of noise in a room, as caused by a certain source of noise, is dependent on the total amount of absorption. Small rooms have small areas available for treatment and so Type BB Acousti-Celotex will be required to produce a substantial noise reduction. In small rooms it is sometimes desirable to cover a portion of the walls as well as the ceiling with Acousti-Celotex. Large offices have larger areas which can be treated and these furnish more units of absorption. Where large areas of Acousti-Celotex can be used,

Type B Acousti-Celotex is very effective.

It should be remembered that the measure of the effectiveness of a quieting treatment is the total number of units of absorption which it furnishes. A comparison of quieting treatments on the square foot basis means nothing without a simultaneous comparison of absorption coefficients. One thousand square feet of a material having an absorption coefficient of .50 will have the same quieting effect as two thousand square feet having a coefficient of .25, provided both treatments are distributed around the room about equally.

Many absorbing materials have a much greater ability to absorb sounds of one pitch than those of another, which results in an unnatural distortion of sounds. The resulting unpleasant sensation is a depressing "deadness", avoided where Acousti-Celotex is used. *For Acousti-Celotex has a remarkably even absorption over the whole pitch range.* You are not continuously aware of its presence but unconsciously benefit by its quieting effects.

Other Uses

Offices have been the chief rooms considered in the discussion of quieting. The principle of quieting noise by absorption can be applied to a variety of uses. In the machine room or shop, where the loudness of sound is high, it is difficult to talk against this "noise pressure" in giving instructions to apprentices and employees. Acousti-Celotex will reduce the loudness of the noise and make speech less tiresome and more intelligible. In hospitals and schools, Acousti-Celotex on the ceilings of corridors will prevent the long passages from acting like speaking tubes in carrying sound from room to room. Numerous other uses will suggest themselves. Even the terrific conditions of an indoor shooting range are tempered by the noise-absorbing qualities of Acousti-Celotex. It is not the complete solution of all noise problems but it will give very noticeable relief in the majority of them.

TECHNICAL DATA ON ACOUSTI-CELOTEX

ACOUSTI-CELOTEX is made by a patented process from Celotex Standard Building Board, perforated with a large number of drilled holes to increase its sound absorbing efficiency. The types and sizes in which it is made are illustrated on the opposite page.

Sound Absorbing Efficiency

The sound absorbing values of Acousti-Celotex are based upon the standard frequency of 512 vibrations per second, a tone one octave above middle C. This frequency was selected by Professor Wallace C. Sabine of Harvard University as best for acoustical calculations because it is at the center of the pitch range most used in music and speech. Recent investigations of the characteristics of office noise show that the same frequency is also most satisfactory as a basis for comparison of quieting treatments.

The authority for the values given below is Professor F. R. Watson of the University of Illinois. The figures shown indicate the portion of the sound energy absorbed at each impact of a sound wave. One square foot of surface, which absorbs all sound that strikes it, has a value of one sound absorbing unit. Type B Acousti-Celotex absorbs 47 per cent of the sound energy which strikes it and hence has a value of .47 sound absorbing units per square foot or a coefficient of .47.

Type	Thickness	Coefficient
BB	1¼"	.70
B	13/16"	.47
C	⅜"	.30
A	13/16"	.25

The sound absorbing efficiency of a material at other frequencies higher and lower than the standard pitch given above is of importance in the preservation of tone quality. Quieting noise without creating oppressive "deadness" also requires that sounds of all pitch be as thoroughly absorbed as possible. Acousti-Celotex has a remarkably even absorption over a wide range of pitch. Additional information on this subject will be furnished upon request.

Effect of Paint

The perforations in Acousti-Celotex give to it a property which is unique in absorbing materials. Types B, BB and C Acousti-Celotex can be painted with any kind of interior paint without appreciably affecting the absorbing efficiency so long as the holes are not closed over.

With Type A Acousti-Celotex, paint should not be used as it will seriously affect the absorbing value. Stains which soak into the board and do not destroy the porosity of the surface may be used if colored surfaces are desired.

Light Reflection

In offices or other rooms, where a surface is desired having a higher light reflection factor than the natural surface of Acousti-Celotex provides, white or light cream interior paints may be used to advantage. Curtis Lighting, Incorporated of Chicago give the light reflection factor of such a surface as 65 per cent indicating that a painted Acousti-Celotex ceiling meets even the requirements of a completely indirect lighting system.

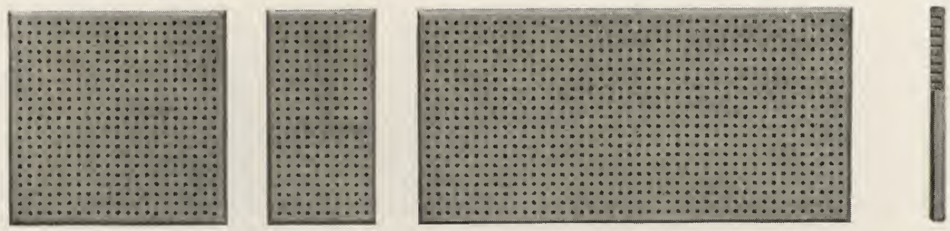
ACOUSTI-CELOTEX TYPES AND SIZES

Type B

Sound Absorption Coefficient .47

Thickness

12″ x 12″ 6″ x 12″ 12″ x 24″ 13⁄16″

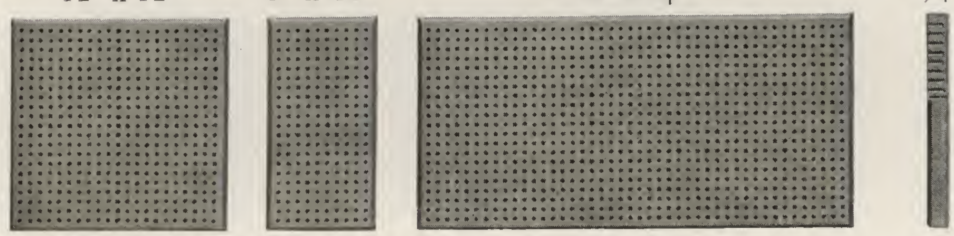


No. 720 No. 710 No. 730

Type BB

Sound Absorption Coefficient .70

12″ x 12″ 6″ x 12″ 12″ x 24″ 1¼″

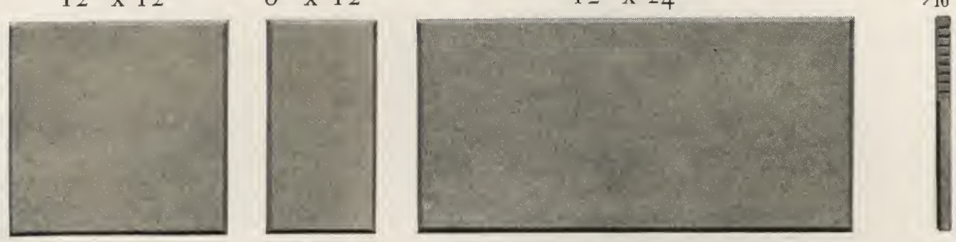


No. 820 No. 810 No. 830

Type A

Sound Absorption Coefficient .25

12″ x 12″ 6″ x 12″ 12″ x 24″ 13⁄16″

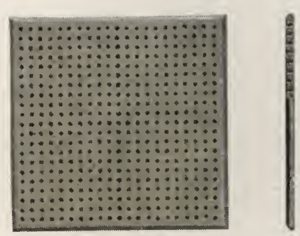


No. 620 No. 610 No. 630

Type C

12″ x 12″

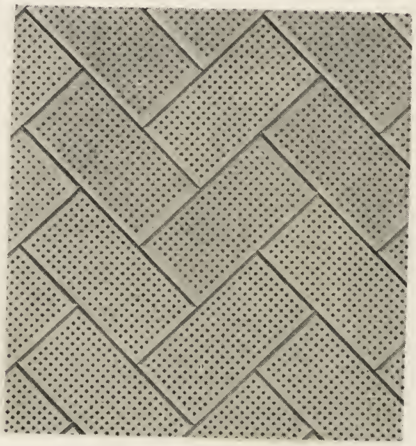
Sound Absorption Coefficient .30



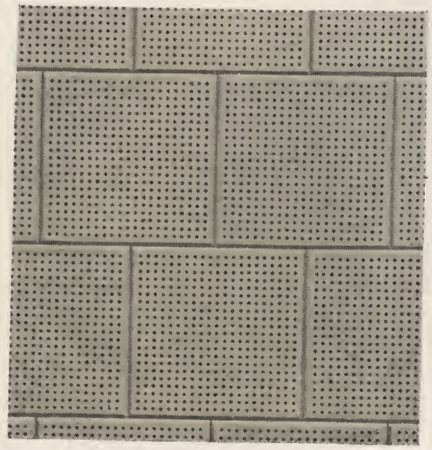
3⁄8″

No. 920

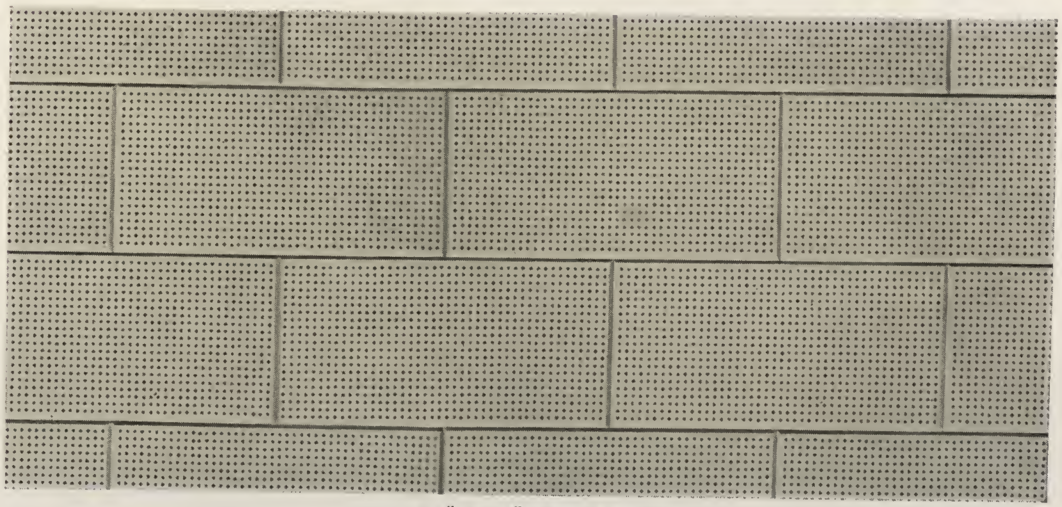
ACOUSTI-CELOTEX PATTERNS



6″ x 12″ Herringbone

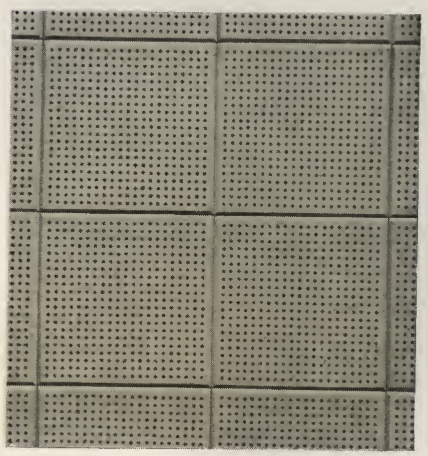


12″ x 12″ Broken Lines

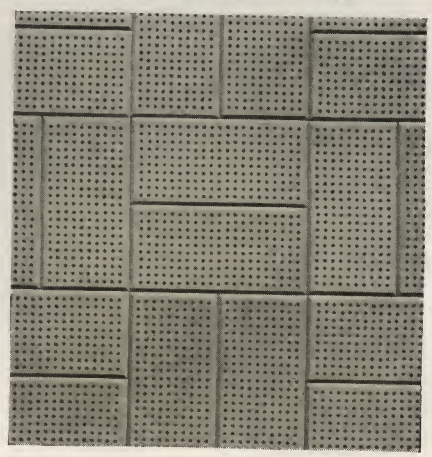


12″ x 24″ Ashlar

12″ x 12″ Straight Lines



6″ x 12″ Basket Weave



THE APPLICATION OF ACOUSTI-CELOTEX

Cementing and Nailing to Plaster

Acousti-Celotex is light in weight and the tile can be cemented and nailed satisfactorily directly to plaster. Where this method of application is used, the plaster must be hard and firm. Gypsum plaster is recommended. On new work the finish coat of plaster can be omitted provided the brown coat is leveled to an even surface.

A special kind of cement, as recommended by The Celotex Company, is spread over the back of the tile. Nails driven into the corner holes or into the edges of the tile at an angle hold the tile in place against the plaster allowing the cement ample time in which to set.

Nailing to Wood Strips

Acousti-Celotex may be applied by nailing it to 1″ x 3″ soft wood furring strips spaced 12″ on centers, or in accordance with the requirements of the design. On concrete or other masonry construction costs are reduced by placing wood grounds 3′ on centers, or as the construction demands, and then nail strips across these 12″ on centers.

In applying the strips to metal lath and plaster or to hollow tile, toggle bolts are used. In concrete or brick, expansion bolts or plugs are satisfactory or, on new work, clips or grounds can be placed during construction.

Nailing to Wood Ceiling

Some churches and other auditoriums have plank roofs with the bottom side of the planks exposed in the room below. In such cases the Acousti-Celotex can be nailed directly to the wood ceiling.

Applying to Special Suspended Ceiling

Most large auditoriums have suspended ceilings and on new work the ceiling construction can be adapted to the application of Acousti-Celotex with a saving in cost. The detail on Page 45 shows the construction.

After the suspended ceiling framework has been erected and the metal lath wired to it, wood furring strips may be applied directly against the lath and wired firmly to the framework behind. Plaster may then be applied to the lath between strips and flush with them. After the plaster has dried sufficiently, the Acousti-Celotex can be applied to the ceiling by nailing to the wood strips.

Borders and Mouldings

In the application of Acousti-Celotex in any of the various tile patterns, it is usually necessary to cut tile around the edges of panels or to provide for some kind of a border. Type A Acousti-Celotex is recommended as a border around panels and can be cut to fit as required.

In many cases the area of Acousti-Celotex required is less than the total area of the ceiling panels. The Acousti-Celotex panels can be set into the larger ceiling panels by recessing the plaster back of the Acousti-Celotex so as to bring the surface of the Acousti-Celotex level with the surface of the plaster border.

Around the edges of panels where Acousti-Celotex meets plaster or other surfaces, a moulding of wood or some other material should be used to give a finished and workmanlike appearance.

Alignment of Tile

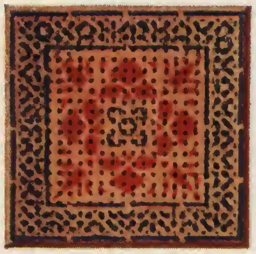
Practically all Acousti-Celotex is applied in some one of the tile patterns shown on Page 40. Laying out the job properly and maintaining true lines during application are absolutely essential to the good appearance of the finished installation. Care and experience in application are necessary and the Acousti-Celotex merchandising policy, in providing for the application of Acousti-Celotex by experienced Acousti-Celotex Contractors, assures satisfactory installations.

PRE-DECORATED ACOUSTI-CELOTEX

THE sample designs on the opposite page illustrate the endless variety of color effects possible with pre-decorated Acousti-Celotex. By special process any of these designs or your own original pattern can be printed by a Chicago firm on Acousti-Celotex, at surprisingly reasonable cost.

Where higher light reflection than that provided by the natural color of Acousti-Celotex is desired, it is important to remember that paints can be applied without appreciably reducing the sound absorption value, except in the case of Type A Acousti-Celotex.

Suggested Stencils for Pre-decorated Acousti-Celotex



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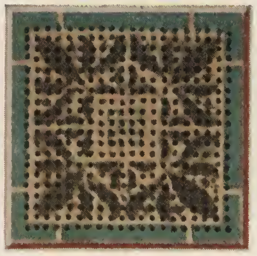

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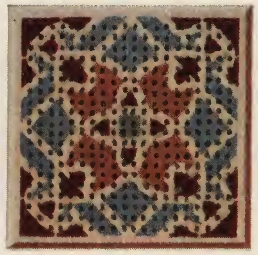

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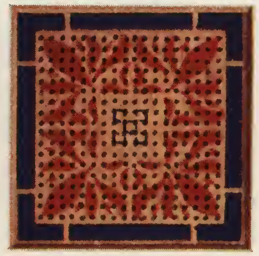

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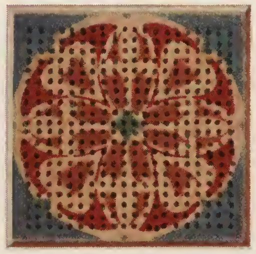

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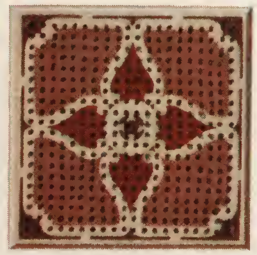

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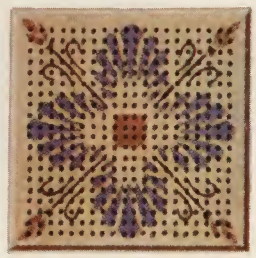

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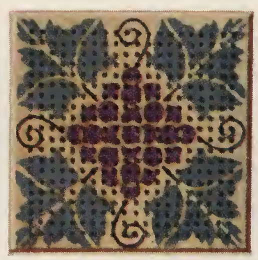

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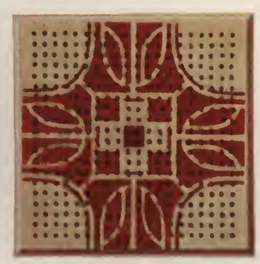

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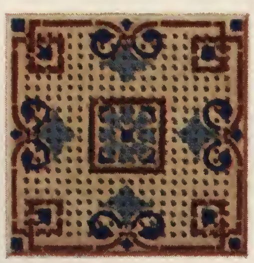

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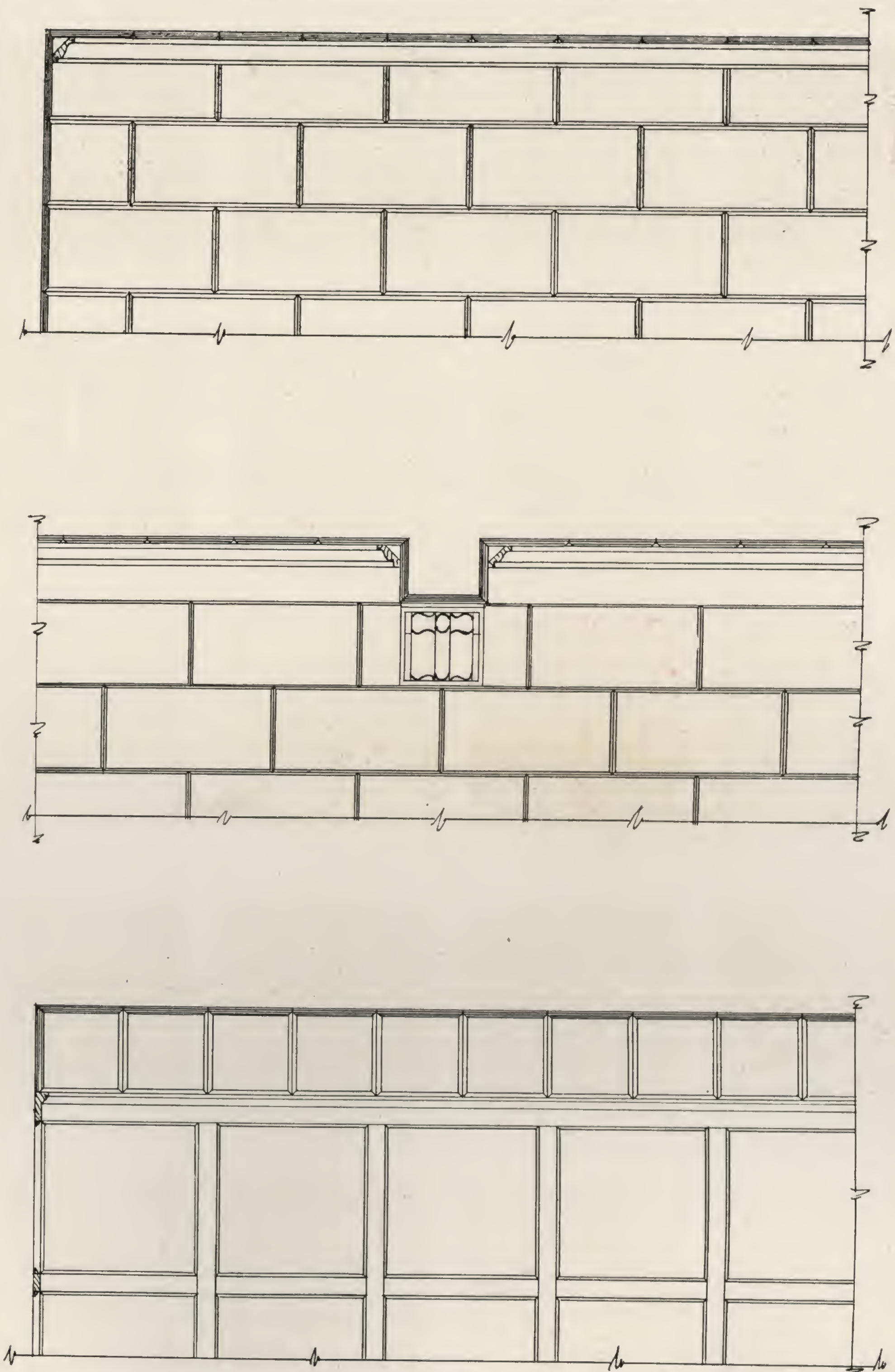
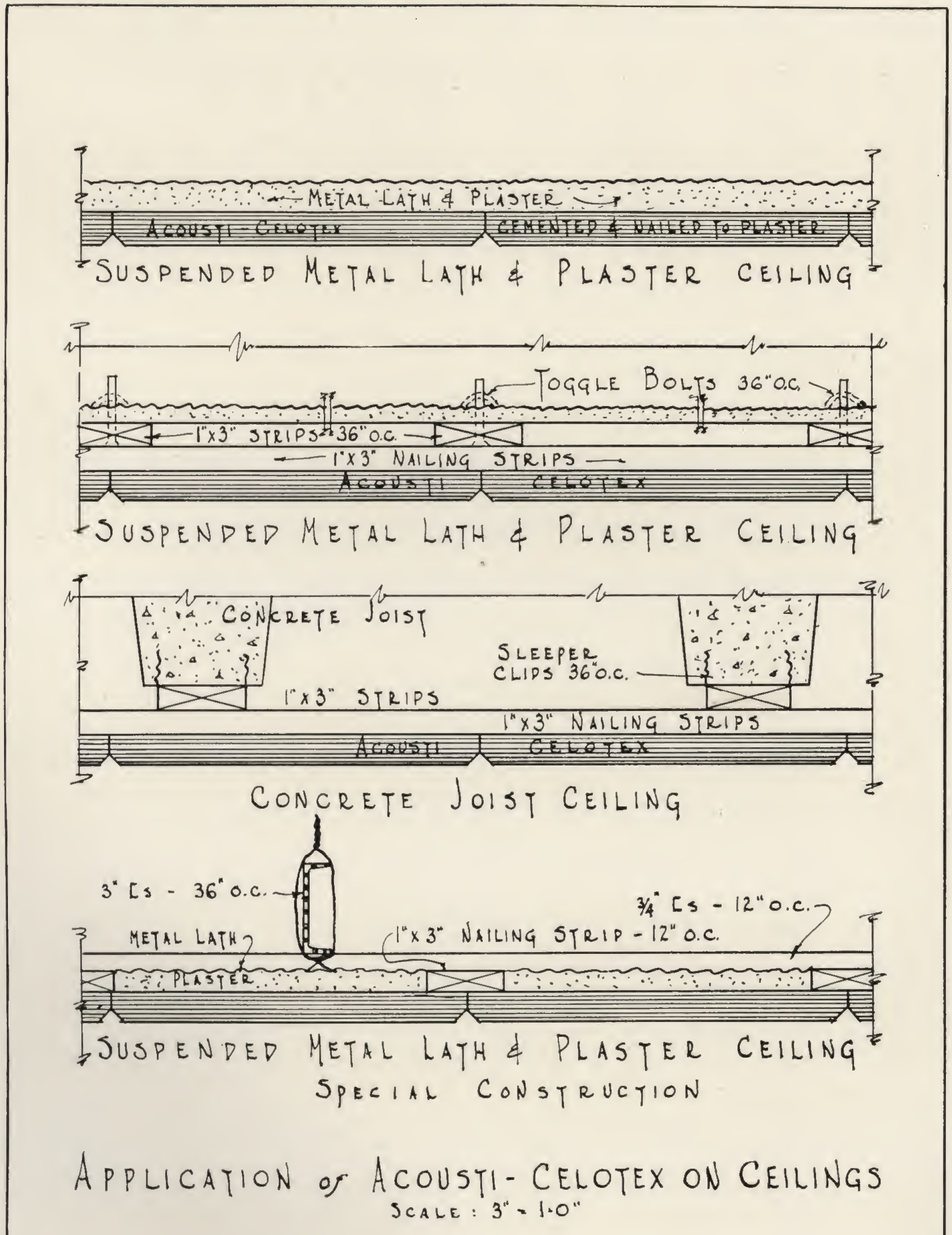


SUGGESTED BORDER & WALL DESIGNS FOR ACOUSTI-CELOTEX


METAL LATH & PLASTER
ACOUSTI-CELOTEX
CEMENTED & NAILED TO PLASTER
SUSPENDED METAL LATH & PLASTER CEILING
TOGGLE BOLTS 36" O.C.
1"x3" STRIPS 36" O.C.
1"x3" NAILING STRIPS
ACOUSTI CELOTEX
SUSPENDED METAL LATH & PLASTER CEILING
CONCRETE JOIST
SLEEPER CLIPS 36" O.C.
1"x3" STRIPS
1"x3" NAILING STRIPS
ACOUSTI CELOTEX
CONCRETE JOIST CEILING
3" [s - 36" o.c.
3/4" [s - 12" o.c.
METAL LATH
1"x3" NAILING STRIP - 12" O.C.
PLASTER
SUSPENDED METAL LATH & PLASTER CEILING
SPECIAL CONSTRUCTION
APPLICATION of ACOUSTI-CELOTEX ON CEILINGS
SCALE: 3" = 1-0"

DISTINCTIVE ADVANTAGES OF ACOUSTI-CELOTEX

1. *Sound Absorption.* Type B Acousti-Celotex has a coefficient of .47, while Type BB at .70 offers the maximum sound absorption on the market today. These coefficients are attested by independent authorities, *and are not variable* as the product is machine produced and controlled by manufacturing standards.

2. *Appearance.* Pleasing in its natural buff color, Acousti-Celotex tile may be arranged in a variety of patterns to suit the individual taste. In mass, the drilled indentions at a distance from the eye enrich the surface with a texture reminiscent of old Spanish indented tile. Plain color or stenciled decoration may be added without fear of affecting the sound absorption.

3. *Fool-proof.* Acousti-Celotex goes into the building as it leaves the factory, unaffected by the precision of the installing mechanic. Being a complete unit, no finishing processes are necessary, processes which sometimes interfere with results.

4. *Upkeep.* Unlike previous materials, dependent for sound absorption upon minute surface porosity, Acousti-Celotex (except type A) can be painted without appreciable reduction of efficiency. Cleaning by means of a brush or a vacuum is simple and easy.

5. *Easily Installed.* Installations have been frequently made in offices and banks during working hours. Acousti-Celotex contractors devote special attention to work of this kind.

6. *Permanent.* Acousti-Celotex is a strong, rigid fibre tile. It successfully withstands the impact of basketballs and handballs in gymnasium use, and does not wear out. And it can be salvaged and used again.

THE ACOUSTI-CELOTEX SALES POLICY

Acousti-Celotex is sold through carefully selected and approved Acousti-Celotex contractors. By this policy, users of Acousti-Celotex are assured of a continuing responsibility for its proper and permanent application.

If you are not in touch with the Acousti-Celotex contractor in your locality, write the Celotex Company, 645 North Michigan Avenue, Chicago, Illinois, and they will instruct their nearest contractor to call on you.

Good Acoustics is a
Matter of Choice...
Not Chance

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